EXTENDED ABSTRACT

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Florent Poux – University of Liège, Geomatics Unit – fpoux@uliege.be
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Point cloud acquisition and processing workflows are usually application-dependent following a classic progression from data gathering to deliverable creation. While the collection step may be specific to the sensor at hands, point-cloud-as-a-deliverable upsurges, becoming one de-facto choice for many industries. This task-oriented scenario mainly considers these as a spatial reference – which is used by experts to create other deliverables – thus being a project's closest link to reality. It brings accurate real-world information which could allow decision-making based on digital-reality instead of interpreted or not up-to-date information. However, there are several considerations to address for a suitable integration. Point clouds are often very large depending on how much data is collected – usually in the realms of Gigabytes, if not Terabytes – and are destined to be archived as a reusable support to create new type of data and products. This can lead to a dead-end with exponential storage needs, incompatibility between outputs, loss of information and complicated collaboration. These practices also show limited to no attempt to generalize a framework which could in turn play as a common ground for further interoperability and generalization. This lack is counterproductive and could lead in term to a chaotic data repartition among actors and worsen the dependency to several outsourced service, each aiming an application independently.

This primarily emphasize a strong need to study interoperable scenarios in which one point cloud could be used by many users from different domains, each having a different need (E.g. the object of interest can be a building or only the roof of this building). This will in turn introduce new constraints at the acquisition level to define the needed exhaustivity of the 3D representation for use with reasoning engines. Of course, this serialize additional challenges for interconnecting processes and insuring a compatibility with the different sources, volumes and other data-driven parameters.

Secondly, robotics research has made a leap forward providing autonomous 3D recording systems, where we obtain a 3D point cloud of environments with no human intervention. Of course, following this idea to develop autonomous surveying demands that the data can be used for decision-making. The collected point cloud without context does not permit to take a valid decision, and the knowledge of experts is needed to extract the necessary information and to creates a viable data support for decision-making. Automating this process for fully autonomous cognitive decision systems is very tempting but poses many challenges mainly link to Knowledge Extraction (KE), Knowledge Integration (KI) and Knowledge Representation (KR) from point cloud. Therefore, point cloud structuration must be specifically designed to allow the computer to use it as a base for information extraction using reasoning and agent-based systems. Interoperable approaches which permits several actors to leverage one common information system (E.g. Facility Management 4.0) based on a digital twin is a great exploration motor. In this continuum, the presentation feeds a broader reflexion to go from a human-centered process to an autonomous workflow which highlights a need to improve automation, data management and interaction to speed-up inference processes, crucial to the development of point clouds in 3D capture workflows.

The presentation primarily aims at providing all the necessary information for the development of an infrastructure: The Smart Point Cloud (SPC). It permits to handle point cloud data, manage heterogeneity, process and group points that retain a relationship regarding a specific domain ontology that allow to query and reason for decision-making tools including smart modelling. The resulting implementation of the SPC is based on new meta-models that permit to structure the information (3D geometry and semantics) and leverage available knowledge for accessing decision-making support tools and reasoning capabilities. At the frontier between a point cloud GIS system and a spatial infrastructure for agent-based decision support systems, its flexibility allows to evolve with future developments using artificial intelligence and new machine learning approaches. The proposed modular infrastructure includes Knowledge Discovery

processes with Knowledge Integration and Knowledge Representation as ontologies, proving efficient context-specific adaptation. The presentation's envisioned directions include:

- A new interoperable and low-level point cloud data instance segmentation approach that account the variability of domains for higher-end applications. It only leverages X,Y,Z coordinates and is provided along an ontology-based contextual classification for direct semantic enrichment;
- A new Smart Point Cloud scheme that serves as an interoperable and modular architecture for unified processing. The concept allows easy integration into existing workflows and application specialisation through the integration of domain knowledge (e. g. Scan-to-BIM);
- A system to leverage formalized knowledge and expert systems based on point clouds. It permits to take advantage of computer reasoning over semantic representations of our environment through multi-modal 3D modelling and ontology-based Knowledge Representation.